Forestry

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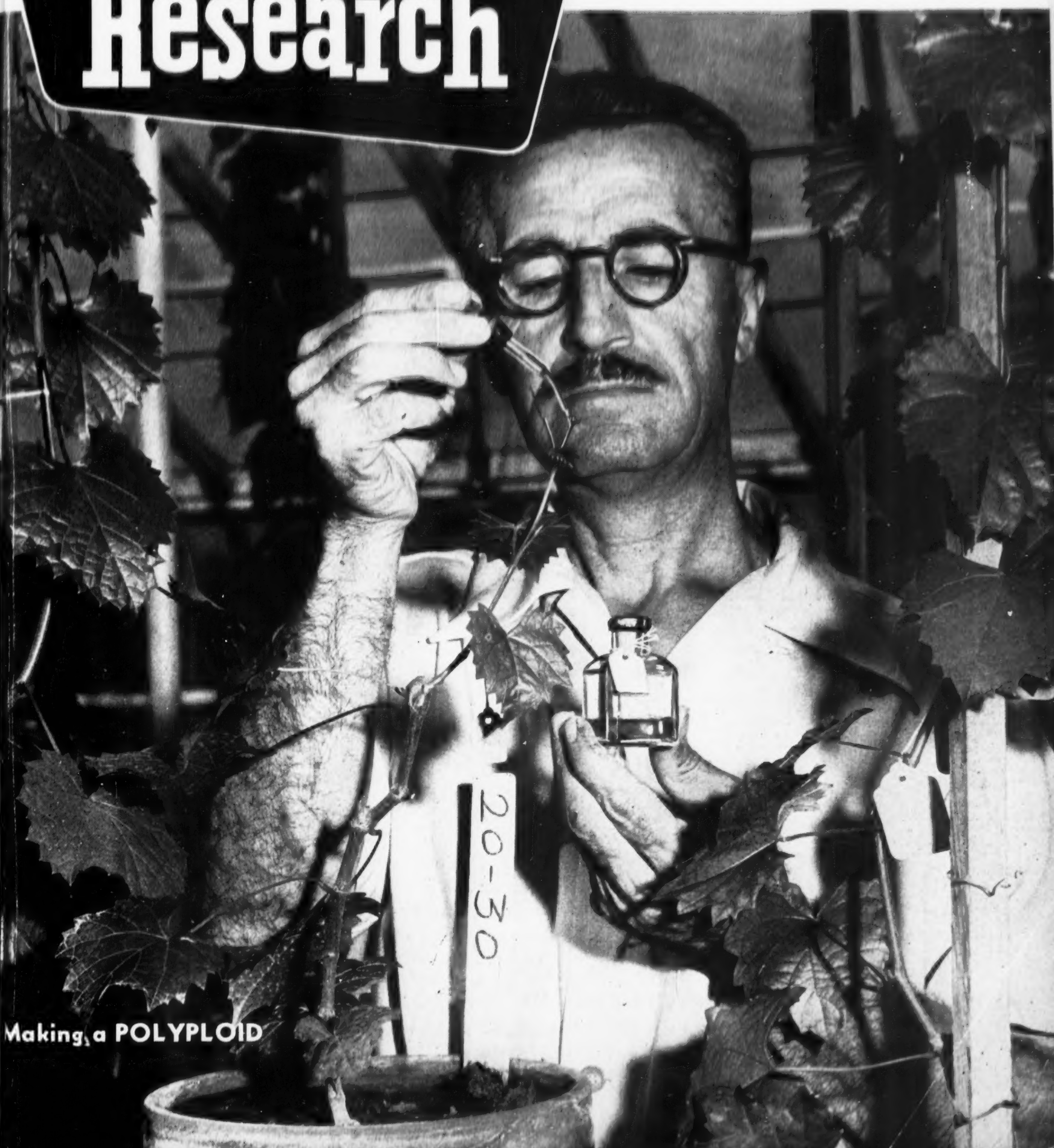
AGRICULTURAL Research

OCTOBER 1953



Making a POLYPLOID

AGRICULTURAL
Research

VOL. 2—OCTOBER 1953—NO. 4

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JOSEPH SILBAUGH—ASS'T EDITOR

From yardsticks to Geiger counters

The auto industry couldn't adopt assembly-line methods till it learned how to measure one-thousandth of an inch. More efficient production of research results likewise demands better measuring methods.

Making scientific measurements easier, faster, and more accurately, or discovering how to measure the previously unmeasurable, is vital to agricultural research. Some recent examples of how it's done—in new tests for soils and oilseeds—are reported on pages 6 and 7.

We live in an era of great advances in research tools. Radioactive tracers, electron microscopes, chromatography, ion-exchange resins, and many other such devices—all essentially measuring instruments—offer incalculable new opportunities for scientific progress. Considerable research effort is rightly devoted to their continued development and adaptation to new uses. The scientist of yesterday could learn a lot with a good yardstick. But to gain important new knowledge today, he'll more likely need a Geiger counter.

New Yearbook of Agriculture

PLANT DISEASES, the 1953 Yearbook of Agriculture, is now available. Its 900-page text by 147 authors, plus 32 color plates illustrating more than 100 plant ailments, makes it the most extensive single work ever published on the ills that plants are heir to. Emphasizing practical aspects of man's fight against plant disease, it deals also with the scientific background of this struggle. It's written to be useful alike to farmers, students, teachers, researchers, and the general reader.

Curtis May of the Bureau of Plant Industry, Soils, and Agricultural Engineering headed the book's editorial committee. Alfred Stefferud of USDA's Office of Information is the editor.

The Department of Agriculture has no copies for free distribution or sale. But there are two ways you may get your Yearbook: (1) Write your Senator or Congressman; he has a limited supply for free distribution. (2) Send an order with $2.50 to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

AGRICULTURAL RESEARCH ADMINISTRATION
United States Department of Agriculture

COLCHICINE drug, applied to the bud of a grape cutting by Dr. Haig Dermen, can result in production of polyploid fruit. How this helps to speed development of improved plants is told on pages 3 to 5. (USDA photo by Forsythe.)

Contents

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Man-made Polyploids can save a million years

Scientists are using a drug to induce genetic changes in plants—changes that nature might never bring about, even over countless ages. This technique, in addition to solving certain mysteries of the plant world, is helping to make new crops and improve old ones.

Known as colchicine, the drug has been used by researchers for treating field crops, flowers, vegetables, and fruits during recent years. Haig Dermen's outstanding fruit experiments at the Plant Industry Station include successful work with grapes the last two seasons.

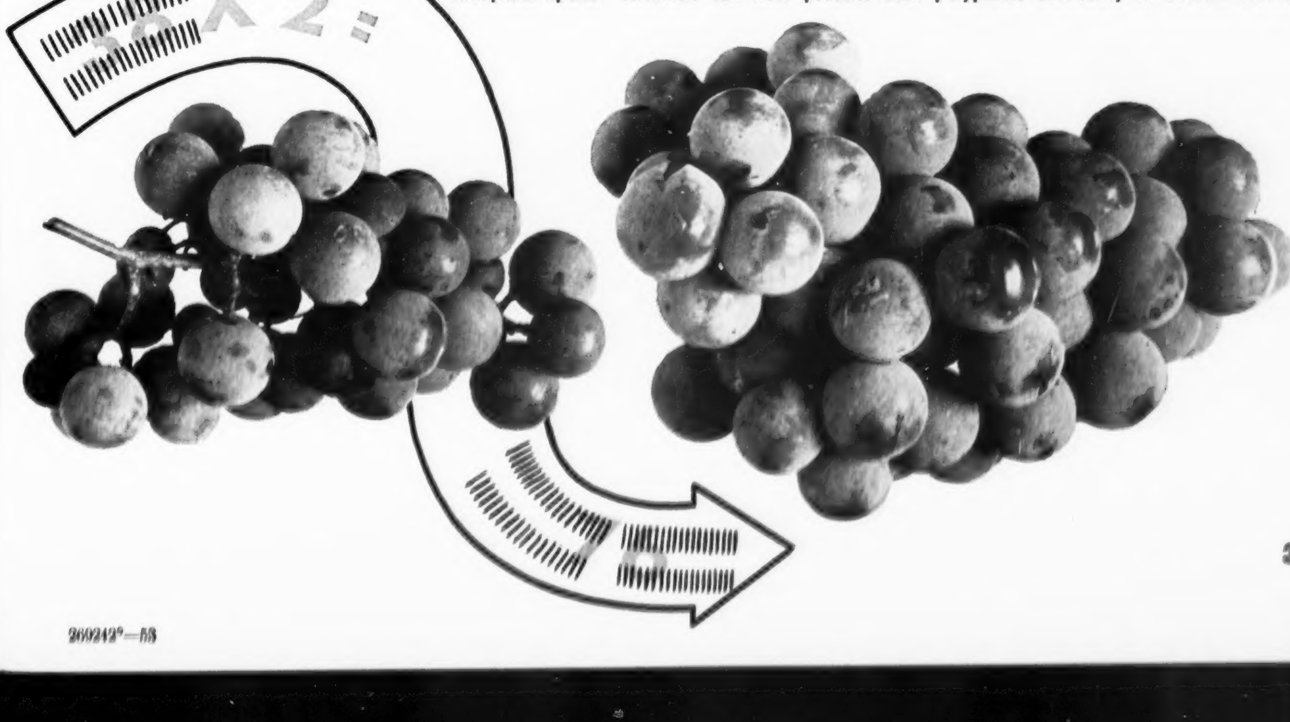
Colchicine is not a magic elixir. Nor is it a fertilizer or a growth regulator. Rather, it goes to the heart of inheritance—the tiny cells of which plants are made. In the nucleus of each cell are bodies called chromosomes. These carry the genetic factors, and every species has a constant chromosome number.

Most plants are diploids—that is they have 2 identical sets of chromosomes in each cell. The raspberry, for example, has 2 sets of 7 (a total of 14 chromosomes). Polyploids are plants with more than 2 sets of chromosomes: triploids (3 sets), tetraploids (4 sets), and so on. Our cultivated strawberries are octaploids (8 sets), and blackberries range from diploid to 12-ploid.

Many polyploids have evolved in nature and are grown commercially today. Through thousands upon thousands of years, sudden variations occasionally appear in plants. Although most of these mutations, or sports, have been lost, some have survived and developed through the process of natural selection. Numerous hybridizations between species have occurred, as has rare spontaneous doubling of chromosomes. (Perhaps the best-known sports are isolated branches bearing giant fruits, found in apples, grapes, and other plants. Dermen's fundamental studies of polyploidy have shown how these double-chromosome sports occur—sometimes on just one side of a branch—and why many can't be used in breeding.)

But we no longer need to wait an eon for an accident of nature to break through the stone walls that scientists have reached in some phases of breeding. Polyploidy, artificially induced with colchicine, may provide in one season just the plant material a breeder needs. The prospects go far beyond production of giant fruit.

Dermen's work with grapes illustrates the point. The southeastern muscadine grape is a diploid with 40 chromosomes. It doesn't cross readily with the northern bunch grape, a 38-chromosome diploid, and the few hybrids are sterile. Yet, bunch grapes need the vigor and disease resistance of the muscadines. They, in turn, need the



CHROMOSOME doubling of the diploid Portland grape (left) resulted in this large-fruited tetraploid sport. Scientists can now produce such polyploids artificially in several fruits.

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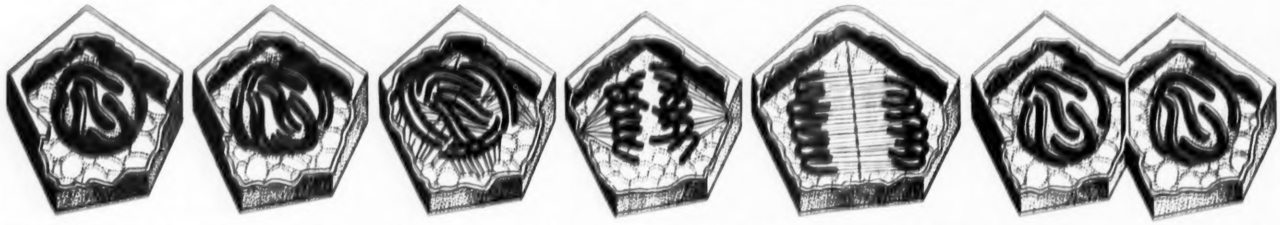
Plants grow by dividing single cells to make identical new ones:



THE CELL is the tiny unit that makes up plants. In its nucleus are inheritance-carrying bodies called chromosomes (a constant number for each plant species). The growth process of cell division begins as the chromosomes shorten, then split lengthwise into two equal parts. Next, slender fibers draw a full set of new chromosomes to each end of the cell, providing a nucleus for each new cell. A wall now builds up between the two masses of chromosomes. Thus two daughter cells are formed, both with the same number of chromosomes as the mother cell.

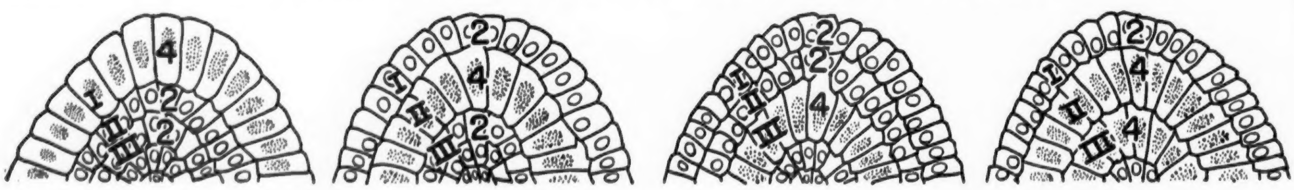
But scientists can step in with a treatment of colchicine drug . . .

COLCHICINE, poisonous drug yielded by fall crocus, prevents cell division from going beyond the second stage (above). Chromosomes divide—but they aren't pulled apart and the cell doesn't split. Result: an enlarged cell with twice as many chromosomes as before the treatment. This cell can divide to form new cells with the doubled number of chromosomes.

Colchicine affects plant cells only during the division process. So applications are most effective on rapidly growing tips and lateral buds, in which many cells are dividing. (Treatment of dormant seeds, lily-bulb scales, and the like has also been successful. Apparently the drug penetrates such material and is held there until cell division begins.)

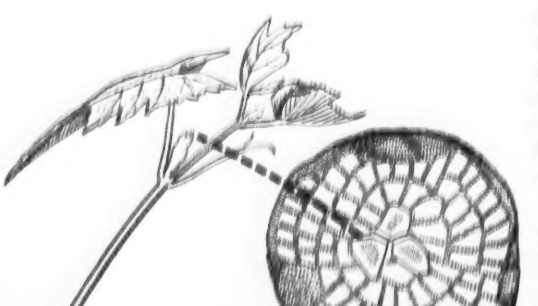
Although colchicine prevents nuclear and cellular division, it does not seem to upset cell growth or splitting of chromosomes. The outer protoplasm grows in proportion to the increase in the nucleus. And chromosomes will continue to double as long as there's enough colchicine present. Repeated multiplication, however, will result in the death of the cell.

and create enlarged cells with doubled sets of chromosomes:



GROWING TIPS of shoots and side buds have three distinct cell layers. Cells of each layer are alike—but give rise to separate tissues or tissue systems in stem, leaves, other organs. (The outer layer, for instance, becomes the epidermis of a stem; stem interior develops from second, third layers.) Colchicine treatment of diploid plant (2 sets of chromosomes) may produce tetraploid cells (4 sets) in 1 or more of the 3 layers. Cells usually divide vertically, but horizontal splitting may let a chromosome-doubled second layer make new cells that become a doubled third layer. Similarly, a tetraploid third layer changes deeper diploid tissues to doubled cells. Reproductive tissues (pollen grains, egg cells) come from second-layer cells; thus, to reproduce tetraploids, Layer II of the parent plant must be doubled.

Structure of the plant and its fruit is often greatly changed . . .



EACH LAYER in a plant tip may have 1 or 2 or 3 cells—no more—at its center. If only 1, and it is polyploidized, the whole layer will become polyploid. When 1 of 2 central cells is affected, doubled cells will develop on half the stem or branch and the other side will be normal. Likewise, with 3 central cells, a third or two-thirds of the layer may become polyploid. Shifts in cell position may change the extent of this polyploidy or transform the layer completely to tetraploid or back to diploid. If chromosomes are doubled in off-center cells, the polyploid area will be limited unless buds are formed at such points.

Colchicine-induced polyploidy shows up in many ways. Enlarged breathing pores on the leaves indicate doubling in Layer-I cells. Oversize pollen grains are a sign of Layer II polyploidy. Doubling of internal cells often results in larger leaves, petals, and fruit.

Scientists can determine polyploidy's extent by using a powerful microscope to make chromosome counts in cells of different layers at the tip of a vigorously growing branch.

large cluster form of the bunch grapes. Experience with other plants suggested the possibility of making a fertile hybrid by doubling the chromosomes of both these diploid grapes before making the cross.

Last year, Dermen treated plants of 10 northern selections and varieties with colchicine (see photos). Tetraploids—the first that man has made in grapes—developed among all 10. Several southern-type plants were polyploidized this season, so the stage is set for new breeding work. Furthermore, there's a chance that some of the tetraploids themselves—with their larger fruits—will become good commercial varieties.

Fertility is a problem in breeding many other plants. Owing to complexities in the reproductive process, a difference in species or a variation in chromosome number is likely to cause trouble. Crossing may be difficult, the offspring largely sterile. In some cases, however, sterile hybrids have been made fertile by chromosome doubling. In other cases, polyploidizing parents (as planned for the grapes) has given good results.

This suggests numerous possibilities: Breeders can make another try with stock that they previously found unusable. Desirable features of otherwise useless plants may be brought into many of our crops. Even completely new fruits might be created. A great deal of breeding material—wild and cultivated—is available, and plant explorers are searching for new stocks.

Much breeding effort has been devoted to getting larger fruit. Selections with good qualities sometimes have to be discarded because their fruit is too small. Polyploidy might solve size at once, allowing scientists to concentrate on such matters as disease resistance, hardiness, plant type, flavor, and nutritional value.

The colchicine method is not the only way of inducing polyploidy in plants. High and low temperatures also have been tried, but the effect is limited and hard to control. Colchicine is far more satisfactory.

Dermen emphasizes, however, that the changes can't always be predicted. Polyploidizing often results in thicker branches, broader and thicker leaves, larger flowers and fruit. But some plants show little or no effect and may even be damaged rather than improved.

Interpreting the results demands familiarity with a microscope and the experimental plant—plus a great deal more: intimate knowledge of plant structure, genetics, and cytology, the study of the cell itself.

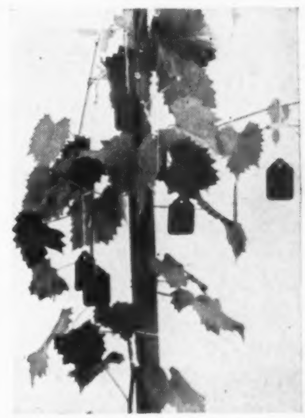
So this job takes experts, and it takes time. Grapes have proved to be excellent guinea-pig plants because they develop quickly. Several years, however, are needed to recognize polyploidy in the slow-growing apple, peach, and pear. But, even so, we're way ahead of nature.

Producing a Polyploid Grape

1. Lateral buds (arrows) are treated with drop of colchicine. Shoot tip, other buds (x's) are taken out to concentrate growth in treated buds.

2. Treatment may slow shoot development. But abnormal leaves on emerging shoots are definite sign colchicine has produced polyploid tissues.

3. These leaves, farther from branch base, indicate that the tip's central cells were affected. Note dark portion, broadness, U-shape at bottom.



4. Tags mark location of promising branches. Cutting back to abnormal leaves may induce polyploid branches to develop from the affected areas.

5. Branches with the abnormal leaves later develop bigger flower clusters (right) than those on normal branch. Pollen grains are found to be larger.

6. Polyploid fruit and normal cluster from same plant. The first man-made polyploid grapes were produced with colchicine this year at Beltsville.

Reliable test for SOIL PHOSPHORUS

Before buying phosphate fertilizer, a farmer needs to know if it will help the crops he plans to grow. Here's a new test that will give him the answer for his particular soil.

It's a chemical test that shows how much plant-available phosphorus a soil contains. Since it reveals the amount of phosphorus in the soil that is usable by plants, the test enables scientists to predict how crops grown on a given soil are likely to respond to added phosphate.

Key to success of the new method is the use of ordinary baking soda (sodium bicarbonate), in a water solution, to dissolve the phosphorus from a soil sample.

This technique is more dependable on a much wider range of soil types than previous methods, and it's especially valuable for testing the neutral and alkaline soils common in the West. Reliable determinations of available phosphorus in these soils were formerly difficult to make.

The new test was developed cooperatively with the Colorado Agricultural Experiment Station by S. R. Olsen, C. V. Cole, F. S. Watanabe, and L. A. Dean of ARA's Bureau of Plant Industry, Soils, and Agricultural Engineering. Most of the work was done at Colorado A. and M. College in Fort Collins. The Western Regional Soils Research Committee aided in sponsoring the project.

This improved method of determining soil phosphorus is now available to the country's soil-testing laboratories, which check more than 1½ million soil samples a year to aid farmers in proper soil management. The sodium-bicarbonate test can be made in less than an hour and is well suited for routine laboratory use.

The solution of sodium bicarbonate ($NaHCO_3$) used in the test is adjusted to a pH (relative alkalinity) of 8.5. Choice of this particular solvent, which gives considerably better results on most soils than chemicals previously used, was based on recently acquired knowledge of how various forms of phosphorus react to each other in the soil, and how these reactions affect the amount of soil phosphorus plants can use.

From the phosphorus extracted by the sodium-bicarbonate solution, sci-

How new test helps diagnose phosphorus needs

WHEN TEST SHOWS A PHOSPHORUS INDEX* OF:	THEN ADDED PHOSPHATE WILL GIVE		
	WHEAT, oats, alfalfa, and other crops with average phosphorus requirements	CORN and other crops that have a relatively low requirement for phosphorus	POTATOES and other crops with a high requirement for phosphorus
Less than 25 lb. P_2O_5 per acre	*INCREASED YIELDS*	*A PROBABLE INCREASE IN YIELDS*	*INCREASED YIELDS*
25 to 50 lb. P_2O_5 per acre	*A PROBABLE INCREASE IN YIELDS*	*(Less likely than other crops to respond to added phosphate)*	*(More likely than other crops to respond to added phosphate)*
More than 50 lb. P_2O_5 per acre	*NO RESPONSE*	*NO RESPONSE*	↓

*NOTE: These indexes are based on results of soil tests made to date. They may be subject to later modification in the light of future experience with the sodium-bicarbonate method.

entists can calculate, in pounds per acre, the quantity of phosphoric acid (P_2O_5) that is available to plants grown on the soil tested.

This tells whether adding phosphorus to the soil, in the form of fertilizer, will benefit the crop to be grown (see diagram). Potatoes and other crops that have small root-zone feeding areas require higher levels of nutrient phosphorus in the soil than crops such as corn, which have roots that are able to draw nutrients from a larger soil area.

During the past two years, Bureau researchers have used the new test to measure phosphorus fertility in more than 200 soils—ranging from strongly acid to alkaline—obtained from various parts of the United States.

Extensive greenhouse and field trials show that results with this method agree closely with actual plant uptake of phosphorus from the soil and with yield responses of various crops to applied phosphates.

The test stands up well also when its results are compared with "A" values of soils. These are precise measurements of plant-available phosphorus obtained through use of radioisotopes. The "A"-value formula was developed by Bureau scientists Maurice Fried and L. A. Dean. This complex analytical method serves to calibrate the easier-to-use chemical test for soil phosphorus.

Complete results of the soil-testing program in which the sodium-bicarbonate test was employed are now in process of publication. However, a preliminary report has been sent to soil-testing laboratories in all the States and in several foreign countries, and many of them are already trying this technique.

With this new test for soil phosphorus, research has taken another step toward better understanding of farm soils and how they can be used for more efficient and economical production of crops.

Measuring OIL VALUE in soybeans and flaxseed

Soybeans and flaxseed are valuable mainly for their oil. Yet oil content and quality—which vary widely in different lots of seed—are not considered in oilseed grading.

The reason is, we've had no quick way to measure these factors.

But recent research has found new methods to do the job. Rapid and simple enough for routine use, they make possible important changes in marketing standards for these crops.

Equipment and procedures for the new oil tests were developed by W. H. Hunt, M. H. Neustadt, and Lawrence Zeleny of USDA's Production and Marketing Administration.

Returns to growers from soybeans and flaxseed now depend largely on yield per acre and general condition of the crop. Consequently, a farmer has little incentive to try varieties that offer more oil of better quality per bushel of seed. But if oil content and quality are included in grading standards, oilseeds of higher oil value may well bring better prices.

Determining the amount and quality of oil by previous methods takes highly trained technicians 6 to 8 hours per sample. The new tests can be made in 10 to 15 minutes, and operators without technical training easily learn to use them.

To measure oil content, a special solvent (orthodichlorobenzene) is added to the seed sample, which is then placed in a high-speed grinder-extractor. The propeller-like blade of this machine quickly pulverizes the seed, while the solvent simultaneously extracts the oil.

The resulting oil-meal-solvent mixture is filtered, leaving a solution of oil and solvent. This is poured into an electronic tester, which measures the solution's dielectric constant—or its ability to impede the flow of high-frequency alternating current. Since the dielectric constant of the solvent is known, any change due to the presence of oil can be measured, and from it oil content of the seed is determined.

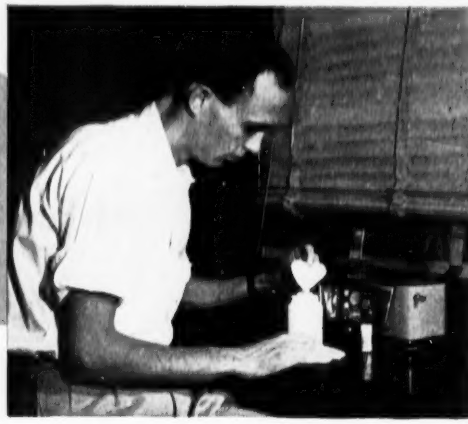
Checking oil quality is even simpler. A drop or two of oil, squeezed from the seed with a laboratory-type hydraulic press, is put in a tubular device called a hand refractometer. Pointing this instrument toward the light, the operator sights through it and obtains a reading. It measures the degree to which light waves are bent as they pass through the oil. This index of refraction is closely correlated with oil quality as determined by chemical means.

The quality of oil largely depends on its chemical "unsaturation"—or reactivity—measured in "iodine numbers" obtained from a standard test that shows how much iodine can combine with the oil. Refractometers used in the new test are calibrated in iodine-number units.

A relatively unsaturated oil (high iodine number) has good drying properties, because its molecules readily combine with oxygen. It's valuable for paints and varnishes. A more saturated oil (lower iodine number) is chemically more stable, less subject to flavor changes, and so is desired for food products.

Work is now underway to adapt the new tests for oil content and quality to other oilseeds, including sesame, sunflower, and safflower.

1
Greenhouse test



1. Less than one-third ounce of chemical is enough for primary screening program to see if a compound has herbicide possibilities. Material is put in this container, then solvent is added to make a spray solution. (If there's only a pinch of a chemical available, an atomizer can be used to apply it.)

2. Metal flats are seeded with 2 groups of plants: 4 crops (corn, soybeans, wheat, cotton) 1 ½ inches deep; and 4 weeds (mustard, crabgrass, pigweed, ryegrass), ¼ inch deep. Each of these groups includes both grasses and broadleaved plants with different types of germination, and all grow over wide area.

3. Cor... hol... belt th... simple... indicat... rary ap...

The search for new Weed Killers

CHEMICAL WEED CONTROL has become a common farm practice in the last 10 years. And no wonder! Only soil erosion costs farmers more than losses from weeds.

Scientists have developed numerous herbicides that now supplement improved cultural practices. These chemicals can be used at low pressure and low gallonage as pre-planting, pre-emergence, post-emergence, and soil sterilization treatments.

But don't look for a single super-herbicide that will kill all weeds and harm no crops. That's unlikely, because crop plants and weeds are closely related. Today's trend is toward specialization: a specific chemical for a specific purpose.

There are hundreds of compounds, you see, and they affect plants in many different ways. The result depends on how well the chemical is absorbed and translocated in the plant; the plant's genetic background and germination; how long the chemical persists in plant and soil.

A compound may kill one plant but not affect another; the same compound may be harmless to the leaves but deadly when used

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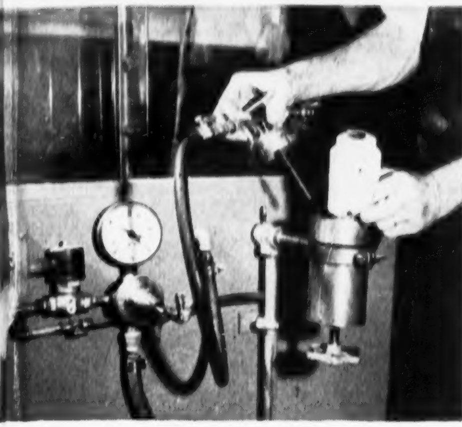
Thi... ...ion ...State ...ompo... new c... 2 year... under

2
Field test

1. Compounds that show activity in laboratory and greenhouse screening are field tested to get more specific information. Less than a pound of chemical is enough for trial on 30 crops. The large number of test plants is necessary for dependable evaluation because most chemicals are specific in action.

2. Application rate depends on results from primary screening. This lightweight spray rig, like the greenhouse equipment, is designed to apply chemicals quickly, uniformly, accurately. Compressed-air storage tank supplies pressure. Speedometer helps operator maintain a steady speed of 2 miles per hour.

3. Spr... (4 ... 5-foot ... include... weed, c... weeds.



3. Container with dissolved chemical is placed in holder on screening table—an electrical conveyor belt that moves test flats under spray nozzles. By simple change of pressure, nozzles, or belt speed (indicated on automobile speedometer), operator can vary application rate without changing the solution.

lles

as a pre-emergence treatment. So it's important to have a screening technique that measures a chemical's over-all activity. Such a technique has been developed by plant scientists in the course of weed research at the Plant Industry Station.

This broad, systematic herbicide evaluation program links manufacturers with State experiment stations, searching for new compounds with local uses. Some 400 new chemicals have been evaluated the last 2 years. Several that seem promising are under more intensive study.

3. Sprayer moves across test field's 600-foot rows (4 rows planted to each of 30 crops) and applies [illegible]-foot plot (140 ft. long) of each treatment. Field includes 4,224 test and check plots. Ryegrass, ragweed, crabgrass, mustard are seeded, insure plenty of weeds. Pre-emergence tests are made in similar field.

4. Each chemical is applied as pre- and post-emergence treatment on crops and weeds. In pre-emergence treatment, chemical is applied at 2, 8, 16 pounds per acre; low rate helps evaluate compounds with high activity, and high rate reveals those with low activity. Post-emergence rate depends on pre-emergence results.

4. Center plots show how pre-emergence treatments killed weeds, causing little injury to corn and cotton but damaging squash, soybeans, other crops. Scientists check response of each crop and weed to each rate of each chemical, pre- and post-emergence. Plant height, degree of kill are recorded and injury rating made.

Electronic Destroyer

of stored-grain insects

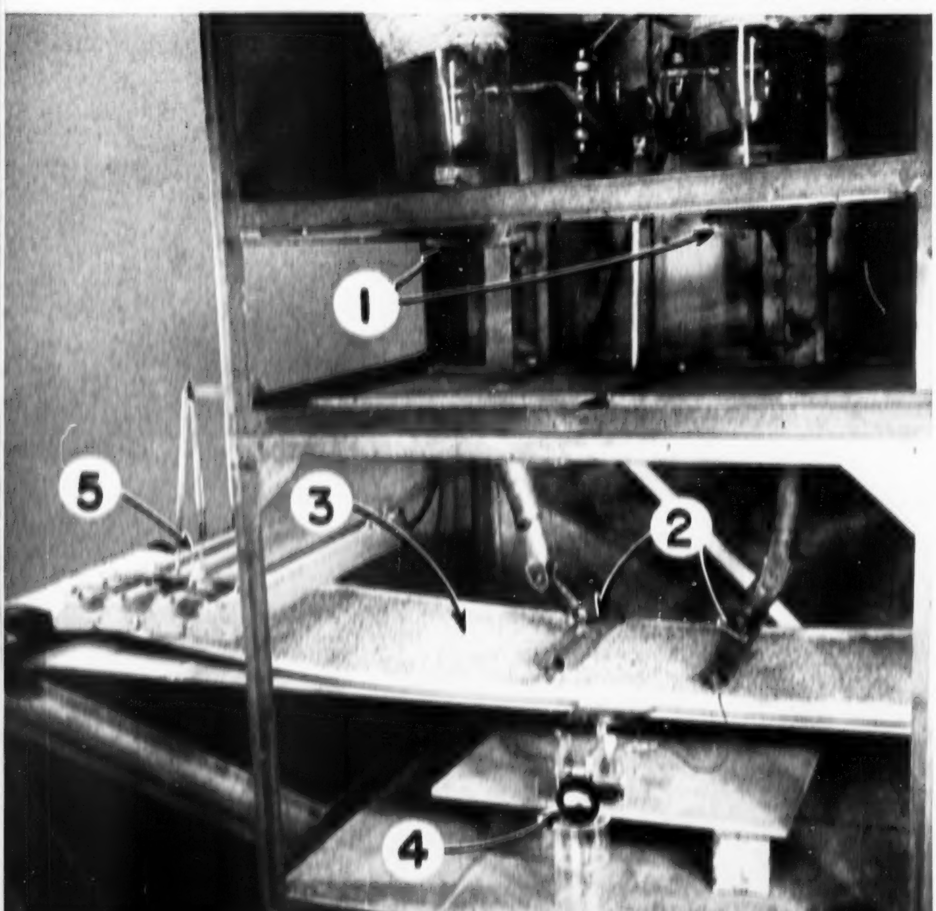
Progress in using radio energy to kill insects in stored crops is reported by ARA engineers and entomologists working with the State agricultural experiment stations of Nebraska, Louisiana, and Texas.

Tests on wheat, rice, and cottonseed show that high-frequency electromagnetic fields of force—employed in the process known as dielectric heating—have practical possibilities for controlling rice weevils in grain and pink bollworms in cottonseed.

Complete destruction of these insects without damage to infested grain has been accomplished experimentally. Equipment and techniques that may permit effective and economical use of the process in large-scale operations are under development.

Main advantage of dielectric heating is that it can generate high heat uniformly throughout a large mass of material in a very short time—often only a few seconds. It is already in wide use by industry—to soften plastics and rubber before molding them into various products, to heat-cure foam-rubber for mattresses, to seal glued joints and sheets of wood in furniture and plywood manufacture, and for other purposes.

EXPERIMENTAL APPARATUS employed in Nebraska tests for dielectric-heat treatment of infested wheat consists of (1) radio-frequency oscillators, (2) heating electrodes, (3) belt conveyor, loaded from left, to move wheat through electrical field, (4) radio-frequency voltmeter to measure field strength, (5) infrared units that speed up process by preheating grain.



One current use directly benefits agriculture. This is the sanitizing of feed bags. A large cooperative feed mill in Buffalo, N. Y., operates two dielectric-heat ovens that can treat 3,400 burlap feed bags an hour at a cost of ½ cent per bag.

Bales of 250 bags, moving through these ovens on conveyor belts, are heated to 220–240° F., which destroys all non-sporeforming germs. Safe reuse of the bags, made possible by this process, cuts the cooperative's bag costs by $5 per ton of feed sold, or well over $3 million a year.

Here's roughly how dielectric heating works. Material to be treated is placed between two electrodes, connected to a high-frequency oscillator, or source of radio energy. The field of force generated by the oscillator surges back and forth between the electrodes millions of times per second. The material under treatment is itself a "dielectric," or non-conducting substance. Its molecules are stressed first one way and then another at great rapidity by the force of the alternating field.

This stress quickly heats the dielectric. Temperatures reached depend on the voltage applied to the electrodes, the distance between them, and the length of time electromagnetic force is applied.

Most of the tests recently reported were made using an oscillator frequency of 40 megacycles per second, somewhat below the frequencies used for television.

In these experiments, insect-infested samples of grain and cottonseed were

treated in plastic boxes. To handle large quantities of seed, however, some sort of conveyor-belt system will be needed (see picture).

Results of State-USDA trials show what can be done. At the Nebraska experiment station, adult rice weevils were destroyed in 12-percent-moisture wheat in 1 second. The grain was heated to 128° F.

Somewhat higher temperatures are required to kill younger stages of this insect. However, germination, milling, and baking tests have shown that no appreciable damage to the grain occurs until its temperature goes above 160° F.

In rice, a total kill of the weevils was obtained at the Louisiana experiment station in 2.2 seconds, by heating the grain to 123° F.

At the Texas station, pink bollworm larvae in 10-percent-moisture cottonseed were killed in 14 to 29 seconds. The seed had to reach 170° F. to assure 100-percent mortality. This is near the temperature at which damage to cottonseed—shown by increased free fatty acids and decreased germination—may be expected.

All these results are from tests of small grain samples treated in plastic boxes. To get similar results with present conveyor-belt systems might cost up to 5 cents a bushel. Finding ways to cut this cost and obtain complete insect kills at lower grain temperatures are current research goals.

Insects now destroy an estimated 5 percent of our cereal grains in storage, costing farmers and elevator operators nearly half a billion dollars a year. Losses from insect damage to cottonseed and other stored crops also run high.

New insecticidal dusts (AGR. RES., May–June 1953) are helping to reduce these losses. Dielectric heating may well become another effective weapon against the depredations of stored-grain insects.

Calves thrive in PORTABLE PENS

Dairy calves protected from parasites in portable pens averaged 28.6 pounds heavier when 6 months old than barn-raised calves. Recent tests show they can maintain this weight advantage as yearlings on pasture.

The barn-raised calves, weakened at an early age by parasites and disease, were not able to catch up, even though they were relatively parasite-free while on pasture.

These are latest results of experiments at ARA's Animal Disease Laboratory, Auburn, Ala., with portable pens for dairy calves.

The pens also proved able to save many calves. Losses from parasites and diseases during the first 6 months are often more than 50 percent of calves in southern dairy herds. With portable pens, losses drop to 10 percent or less.

Calves must be placed in pens within 24 hours after birth. The pens are moved each week to prevent build-up of parasites or disease germs.

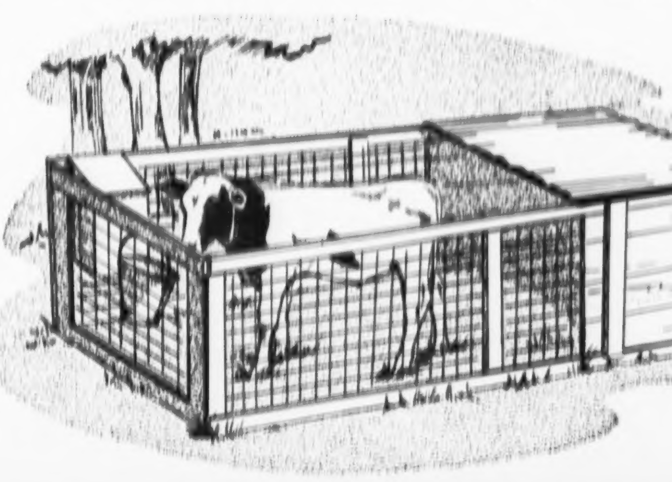
L. R. Davis, parasitologist at the Auburn laboratory, reports that calves in portable pens have been raised free of pneumonia and Johne's disease, with little trouble from worm parasites and coccidiosis. Enthusiastic reports come from 322 Alabama farmers, who last year raised 3,440 calves in 1,590 of these pens. Farmers in other mild-weather States are also getting good results.

Cows from portable pens are more docile and easily handled than those raised in barns. And pens save the money formerly spent to fence exercise yards and pay barn insurance.

Some dairymen who haven't tried the pens question their value during winter. But calves at the Auburn laboratory weren't harmed by temperatures as low as 9° F. Experience of farmers in northern Alabama, Tennessee, and southern Illinois also shows that calves in pens can withstand considerable severe weather.

The pen developed by the laboratory measures 3 x 10 x 5 feet, with movable side and end panels and a roof covering half the pen. Two men can carry it easily. Construction costs vary from 50 cents (for a homemade job of "sawmill edgings" and packing-box cardboard) to about $15 for a shop-made pen of wood, wire mesh, and aluminum roofing.

Plans for the portable pen are available from the U. S. Animal Disease Laboratory, Auburn, Ala.



Ice RIGHT to Save Potatoes

Transit research is paying off for California early-potato growers, who shipped nearly three-fourths of the 1953 crop under modified icing. Scientists have found this not only saves as much as $30 to $40 per car but also gets potatoes to eastern markets in far better condition.

These findings are welcomed, too, by wholesalers, retailers, and housewives, who get a large part of their early potatoes from California. Until this year, too many of these potatoes spoiled at the market.

To find a way to stop this waste, scientists of the Bureau of Plant Industry, Soils, and Agricultural Engineering and the California Agricultral Experiment Station made a series of transit tests.

In four seasons, they crossed the continent with 43 carloads of potatoes, making detailed studies of temperatures, icing services, and equipment, to learn how these variables affected the potatoes. The test results told the story.

California early potatoes, grown in fertile soil with plenty of moisture, are usually harvested in late spring before they have matured. These potatoes skin easily. Sometimes they lose nearly all the coat that protects them from spoilage.

Decay thrives above 75° to 80° F., but at temperatures of 65° to 70° the potatoes can develop a replacement cover that holds in moisture and keeps out spoilage organisms. This healing process slows down at 50°, however, and it will stop if temperatures drop to as low at 40° F.

Thus, early potatoes shipped long distances under heavy icing can't grow new protective tissue. They look bright when unloaded and would be all right if they were kept cold. But after a few days of wholesale handling and retail display—all without refrigeration—they're in trouble. Shriveling, surface browning, and decay develop.

The 4-year study led to these recommendations for keeping potatoes cool enough to avoid decay but warm enough to promote healing:

1. For early-season potatoes with average temperatures below 70° F. when loaded: half-stage icing after loading, plus one re-icing on the fourth or fifth day in transit. (In half-stage icing, grates are raised half-way up in car bunkers and only half a load of ice is used.)

2. For warmer weather, when potato temperatures run 70° to 75°: half-stage initial icing, after loading, and re-icing on the third and seventh days in transit.

3. For moderately warm weather, with potatoes at 75° to 80° when loaded: full-bunker icing after loading and one re-icing on the third or fourth day in transit.

4. For hot weather, when potatoes are at 80° or higher: pre-iced, full-bunker cars and re-icing twice in transit. Precooling cars to about 55° may be advisable. If half-stage cars are used, re-icing should be done at regular stops.

Refrigeration is worthwhile to extend shelf-life of oranges

Retailers can safely display Florida Valencia oranges for 2 or 3 days at room temperature when the fruit is received in good condition. If the oranges are to be held longer or show signs of aging, they must be kept cold—at least overnight.

W. E. Lewis drew these conclusions from recent shelf-life studies at the Plant Industry Station. Lewis ran a series of tests on Valencia oranges, using a typical display room in which daytime air temperature averaged 78° F. and relative humidity about 70 percent. The fruit was displayed 6 days by three methods:

1. In a nonrefrigerated rack. During a 24-hour period, the temperature of this fruit averaged 71°.

2. In a nonrefrigerated rack during the daytime, with storage in a walk-in cooler at night. When overnight storage was at 40°, the 24-hour average fruit temperature ran 54°. Dropping night temperature to 32° reduced the 24-hour figure to 50°.

3. In a mechanically refrigerated case. These oranges averaged 40° over a period of 24 hours.

One lot under each method was sprinkled several times daily, and a duplicate lot was not sprinkled.

Decay was serious only in the oranges that were not refrigerated at all. These losses averaged 13 percent for sprinkled fruit and 17 percent for nonsprinkled lots.

Sprinkling cut moisture loss somewhat, especially in nonrefrigerated oranges, and had no harmful effect.

Lewis warns retailers to watch for rapid deterioration during the late-season period for each variety. (The season for Florida Velencias runs from March through June.)

Details of this study are available from W. T. Pentzer, Plant Industry Station, USDA, Beltsville, Md.

New Advance in GROWTH MODIFIERS

For a long time, scientists have wondered why plants absorb certain compounds more readily than others and move them more easily through stems and leaves. A newly discovered growth modifier may help explain this mystery in terms of a compound's chemical structure.

Known as MOPA (methoxyphenylacetic acid), the new chemical has modified the growth of several plants in preliminary tests by J. W. Mitchell and W. H. Preston, Jr., at the Plant Industry Station.

More significant is the fact that this compound causes a gall to form at the treated part of a young bean stem, followed by a secondary gall at the plant tip. MOPA produces these galls readily and consistently.

The importance of the second gall became apparent when Mitchell and Preston found that a related chemical, phenylacetic acid, produces a similar primary gall on beans—but no secondary gall (see pictures). Evidently, when a certain hydrogen atom of the phenylacetic-acid molecule is replaced by the methoxy group of MOPA, we get a compound that the plant moves more readily and can thus translocate to produce a new gall.

MOPA apparently moves down as well as up: malformed leaves were found on side shoots below the stem area where the chemical was applied.

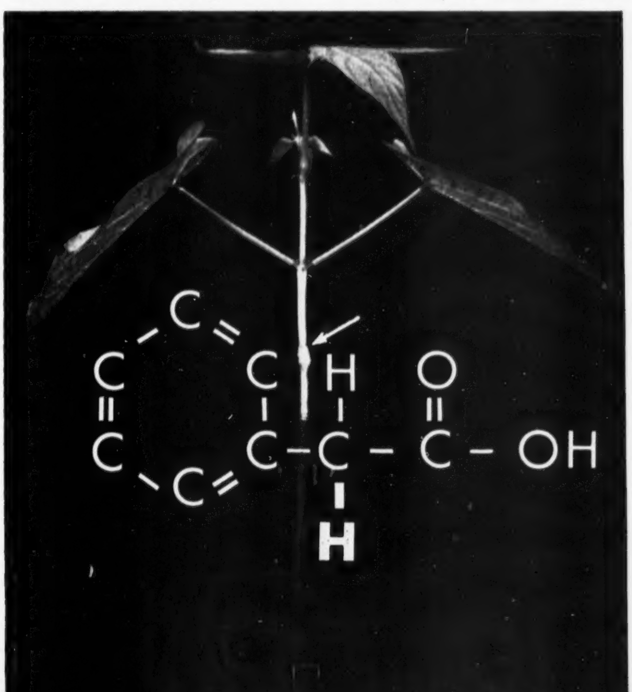
Young cucumber and sunflower plants also responded to MOPA. It stopped tip growth but stimulated side shoots. (This suggests that the compound might have value in making some plants shorter and bushier.) On tomatoes, tip growth was not affected, but treated plants produced 59 times more side growth than those untreated. However, some malformed leaves developed. Corn and barley didn't seem to be affected.

MOPA was first made at the University of Maryland by Wilkins Reeve, who furnished the compound to Mitchell and Preston through the National Research Council. The spectacular results with MOPA have encouraged Reeve to synthesize several related chemicals for plant trials. More than a dozen such compounds—some new, some old—have already been tested as growth modifiers.

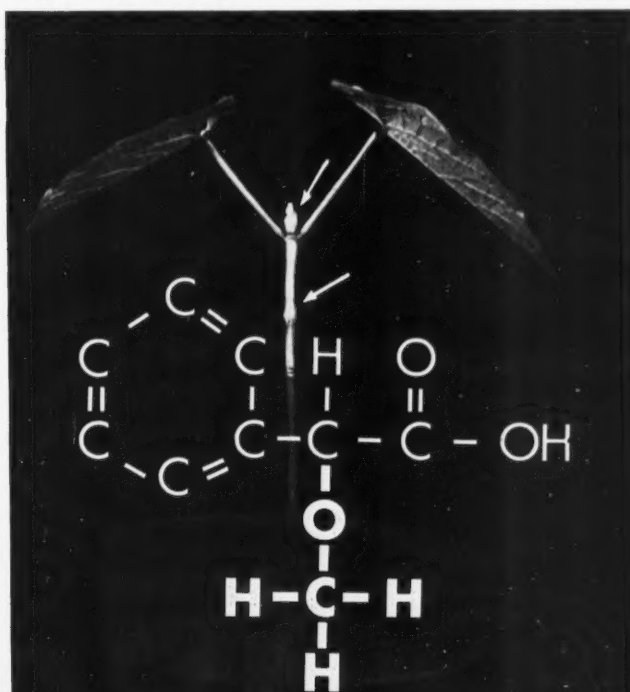
Researchers hope these findings will lead to new forms of the agricultural chemicals we now use—compounds that crop plants can more readily absorb and translocate. For example, chemists might be able to build a new molecule that would combine the usefulness of 2,4-D with the superior movement of MOPA.

At any rate, it seems certain that these explorations will eventually tell us more about how growth modifiers behave in plants.

PHENYLACETIC acid caused formation of a gall and slowed growth moderately when applied to a bean stem. Next photo shows what happened when hydrogen (below) was replaced by methoxy group.



METHOXYPHENYLACETIC acid produced both primary and secondary galls. Compound stopped tip growth, stimulated side shoots. Flowering, fruiting were delayed. Leaf size, shape, number were abnormal.



What it takes to fight FOREST INSECTS

In the field headquarters at Moscow, Idaho, a tense group of men awaits the signal for a large-scale air offensive—first of its kind—against an insect. It's 3 o'clock in the morning, May 22, 1947.

The report comes: weather clear, almost no wind. The message is relayed to three nearby airports. At 3:20 a. m. the attack begins. A big C–47, several old Ford trimotors, and a covey of small planes take the air. Their target: the leaf-eating tussock moth. Mass outbreaks of this insect on Douglas firs in northern Idaho and Washington had turned entire mountainsides from green to brown.

This airborne offensive was the culmination of months of planning, surveying, and photographing by Federal, State, and private agencies and forest owners. About 6 weeks later, when the campaign was over, 413,469 acres had been sprayed with 390,878 gallons of insecticide at a cost of $1.57 per acre. And the tussock moth was stopped in his tracks.

This operation demonstrated that we had economical means for control of insect defoliators over wide areas, especially those inaccessible by land. It set a new pattern for our fight against many of the several hundred forest-insect species, which destroy more timber in the United States every year than is lost to forest fires.

Each year since 1949, 50 million acres of forests in Oregon and Washington have been surveyed from the air to detect and appraise damage by the spruce budworm. Much of the area is inaccessible. The surveys, plus aerial spraying, have succeeded in controlling this insect on nearly 3 million acres of infested forest. The cooperative investment of some 3 million dollars in this program has saved more than 60 million dollars worth of standing timber.

Operations from the air are many times faster and much cheaper than ground operations. In densely forested areas, they may be the only way to get the job done. A recent air survey to appraise damage by the spruce budworm in Maine cost only 18 cents per thousand acres.

To do this job from the ground—if it could be done at all—would require an army of workers. One C–47, properly equipped, can spray in an hour an area that would take 9 ground units with hydraulic sprayers a whole season. This year, a total of 60 million acres have been surveyed and half a million acres have been sprayed in cooperative air operations to control forest insects.

Although aircraft can be used in detecting and spraying leaf-eating insects, they don't help much against insects that feed under the tree bark. Unfortunately, many of our worst forest pests belong in this category. In some regions, during the past two decades, bark beetles and wood borers have destroyed more merchantable timber than the total cut by sawmills and destroyed by fire.

Bark beetles and wood borers must be attacked from the ground—a slow and expensive procedure. The broods must be destroyed by peeling and

GROUND ATTACK is hard, slow job but only practical way to stamp out tree-bark insects.

burning infested bark, applying penetrative spray to the bark surface, or salvaging infested timber. Most borers don't damage living trees but take up where killing insects, diseases, and storms leave off—by attacking dead trees and logs, making them unfit to use for lumber.

A record-breaking control job on one bark insect is ending now in Colorado. Between 1942 and 1948 the Engelmann spruce beetle killed nearly 4 billion board feet of valuable timber—enough to build 400,000 five-room frame houses. In the past 5 years, ground crews surveyed Colorado forests and sprayed the bark of millions of trees—one at a time. An estimated 3½ million dollars has been spent, but the beetle outbreak was checked. Untold wealth in spruce trees has been protected.

While direct control methods against insects continue, research entomologists are hard at work developing more permanent methods of protection. One way is by good forest management.

"Sanitation" logging, for example, is proving both profitable and effective against the western pine beetle in some of our ponderosa pine forests. Studies show that diseased and slow-growing, over-mature trees are particularly susceptible to attack. They are systematically removed and sold as logs. The vigorous, fast-growing, young trees have good resistance to the beetle.

Prevention through biological control is also promising. A virus disease of the European pine sawfly, for example, has proved highly successful in controlling this insect. The disease was brought from Europe by Canadian entomologists, who put it in spray form. Aerial applications of the disease in New Jersey and Illinois last year gave almost complete control. Rechecks this year showed that the virus lived through the winter, which gives hope that the disease may provide permanent control of the European pine sawfly.

Selecting and breeding trees for insect resistance is another angle of attack. Cooperative studies by ARA entomologists and Forest Service geneticists show, for instance, that hybrids of Jeffrey and Coulter pines resist the pine reproduction weevil, a serious pest in California.

From 1934 to 1940, thousands of acres were planted to Jeffrey and ponderosa pines. Survival was good for the first few years. Then the weevil struck. Within the next 10 years, up to 90 percent of young trees in some areas were killed.

In the meantime, a natural hybrid of Jeffrey and Coulter pines was discovered in the San Jacinto Mountains. There were no records of Coulter trees killed by the weevil. The scientists saw in the hybrid a combination of the good qualities of both trees. They began crossing by artificial pollination. Field plantings now show that these hybrids are about nine times as resistant to the weevil as their Jeffrey parents. This research may well revolutionize planting programs for the reforestation of brushfields and burned areas.

Finding and breeding insect resistance into forest trees is a long, tough job. For a tree crop to grow from seed and develop into mature timber often takes longer than the span of a human generation.

As tree-breeding work continues, our field entomologists, backed by research, are striving to increase the effectiveness and to reduce the cost of weapons already at hand—survey techniques, insecticides, parasites, good management. The airplane can contribute to the greater efficiency of all these weapons.

AERIAL SPRAYING *can protect vast areas of forest from leaf-eating insects at low cost.*

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AGRISEARCH Notes

Cooler water helps pigs

Quite a few farmers this winter will use automatic, electrically heated, hog-watering devices. They'll do both their hogs and themselves a favor by making sure these devices don't overheat the water. Tests by ARA engineers in cooperation with the Iowa experiment station show that hogs gain faster when given water at 44° F. than at 60°. Also, of course, cooler water means lower power costs. The tests further demonstrated that maintaining low water temperature is more important for economic operation of automatic hog waterers than are covers on the drinking compartments or insulation of the system. These findings should prove valuable to manufacturers of watering equipment and to swine-nutrition specialists, as well as beneficial to farmers.

Fork lifts for apples

The cost of handling boxes of apples in packing and storage operations can be cut almost in half, tests show, by using fork-lift trucks and 48-box pallets rather than the customary belt conveyor and two-wheeled hand trucks. A study made by the Washington State Apple Commission under contract with USDA's Production and Marketing Administration demonstrated that the fork-lift method costs about $28 less per 1,000 boxes. Most of this saving came from reduced man-hours of labor, an important consideration at harvest time. Fork-lift handling tends to cause fewer bruises but still moves the fruit faster, thus helping to prevent storage losses. Operators in Washington figure that each day in the open after picking takes about 10 days from an apple's storage life.

Handle pears with care

How proper handling can help retailers sell more pears is shown in recent tests by ARA horticulturists at Plant Industry Station, Beltsville, Md. For instance, Anjou pears brought to a desirable stage of ripeness will remain in good condition for several days when displayed in mechanically refrigerated cases. However, if unrefrigerated cases are used for display, it is not a good idea to move the pears to refrigerated rooms for night storage. The handling involved often causes scratches and bruises, which become badly discolored when the fruit is again displayed at room temperatures. Sprinkling pears with water is also not recommended, because it may result in watersoaking at skin breaks, thus lowering both their quality and attractiveness to buyers.

More appealing potatoes

Some consumers will pay more to get clean potatoes, Maine potato people learned in a recent USDA-State cooperative marketing project. When potatoes were washed and packaged in 10-pound and 50-pound bags, they brought 20 cents more per hundred pounds than unwashed potatoes. Tests also showed that putting the variety name on the label led to repeat orders for that variety. Marketing specialists in Maine now urge that potatoes be labeled as to variety, cleaned better, sized more accurately (in 3 sizes), more carefully graded, and marketed in suitable consumer packages.

Better storage for bulbs

Plastic linings for storage boxes will keep bulbs in good condition for several months and help insure better year-round supplies of Easter lilies and similar flowers. N. W. Stuart of ARA's Plant Industry Station reports that packing bulbs with fairly dry peat in boxes lined with polyethylene film largely overcomes danger from too much moisture during long-time storage. His tests show that bulbs kept in the lined boxes maintain higher quality, and so tend to produce more blooms, which more than make up for the cost of the plastic.

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